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ABSTRACT

This guide is intended to train teachers in integrating math skills into the vocational curriculum. Included in the guide are process outlines, handouts, and transparency masters for three workshops designed to assist in the development and delivery of an integrated vocational education and math skills program. The first workshop, a 3- to 4-hour orientation inservice for both vocational and math instructors, is intended to explain the rationale for math equivalency and criteria for meeting math requirements and also to introduce program implementation processes. The next workshop is a 1-day work session for vocational and math instructors that is intended to accomplish the following: identify course sequences, review curriculum guides, work through math checklists to determine specific math concepts being taught, approve course sequences for credit, and select content units that would be developed for presentation and a professional development inservice. The third workshop is a half-day professional development inservice in which both math and vocational teachers make presentations on how selected concepts are taught in their subject areas so as to build mutual respect between the two groups of instructors and establish ongoing relationships within the school setting. The final section is a general checklist for planning, conducting, and evaluating inservice sessions to maximize their effectiveness. (MN)

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INSERVICE GUIDE

for

"AN INTEGRATED VOCATIONAL EDUCATION AND MATH SKILLS MODEL"

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INTRODUCTION

Staff inservice is the key to success of an integrated vocational education and math skills model. The instructor must become committed to the delivery system and understand where math applications can be integrated into the vocational currriculum. Such commitment and understanding can only come through a staff development process.

In order to implement a quality program, the instructor should be involved in three levels of inservice:

Orientation Inservice -- a 3-4 hour session that involves both math and vocational instructors. The rationale for math equivalency and criteria for meeting math requirements should be the focus of this session. Also, next step processes for implementation should be introduced and explained.

Workshop for Validating Math in Vocational Programs -- a 1 day work session of vocational instructors and math counterparts. This session will identify course sequences; review curriculum guides; work through math checklists to determine specific math concepts being taught; approve course sequences for credit; and select content units that would be developed for presentation at the professional development inservice.

Professional Development Inservice -- a 1/2 day inservice in which both math and vocational instructors make presentations on how selected concepts are taught in their subject areas. This builds mutual respect between math and vocational instructors and establishes on-going relationships within the school setting.

This guide is directed toward those school districts that wish to become involved in an integrated vocational education and math skills program and plan to incorporate a math equivalency credit option. An outline of process steps and inservice content is shown for each recommended workshop. (Sections II, III and IV) Example materials are included for duplication and use in the inservice sessions. These handouts are designated (HO) and a number in the upper right hand corner of the page. In the procedures section, reference is made to the use of HO 1, HO 2 and so forth. Transparency masters (TM) are included for the inservice presenter to use in making transparencies for the sessions. References are made to the transparency masters by TM and a number such as TM 6, TM 8, TM 20. This numbering system keys the materials to the procedures of this guide.

Section V is a general checklist for planning, conducting and evaluating inservice sessions to maximize their effectiveness. The checklist should be used by planners to assure that key points are being considered in each stage of the inservice.

This guide is to be utilized with a companion document, "Implementation Guide for An Integrated Vocational Education and Math Skills Model."

II. ORIENTATION INSERVICE

- RATIONALE
- CRITERIA
- COMMITMENT

II. ORIENTATION INSERVICE

RECOMMENDED TIME: 3-4 hour session during school day, evening, release day or school inservice day.

TARGET AUDIENCE: Math instructors, vocational instructors, curriculum directors, vocational administrators, school administrators with responsibility for curriculum.

INSERVICE OBJECTIVES:

1. Inform staff of intent of program.
2. Establish a rationale/purpose for offering integrated vocational education and math skills with a math equivalency credit option.
3. Establish criteria for meeting math requirements through vocational classes.
4. Define processes for implementing the program.

DESIRED OUTCOMES:

1. Math instructor acceptance of math equivalency credit as a viable option.
2. Vocational instructor commitment to integration of mathematics in vocational classes.
3. Willingness of both math and vocational instructors to attend workshop and professional development sessions.

MATERIALS NEEDED:

1. Handouts:
   - Copies of Oregon Mathematics Education Council's (OMEC) paper "Topic Outlines -- Amplification and Discussion" for each participant.
     HO #1
   - Guidelines for establishing math equivalency credit for each participant.
     HO #2
   - Agenda for workshop for validating math equivalency credit. (Next Step.)
     HO #3
   - Evaluation instrument for inservice session.
     HO #4

2. Transparency masters:

   - Summarized version of conceptual paper.
     TM #1 Basic Arithmetic
     TM #2 Measurement Tools
     TM #3 Advanced Measurement Tools
     TM #4 Approximation/Measurement Skills
     TM #5 Types and Units of Measurement
     TM #6 Technical Writing
     TM #7 Extended Projects
     TM #8 Reading and Interpretation/Oral Communication
     TM #9 Computation
     TM #10 Fractions, Percent, Decimals
     TM #11 Money Problems/Extended Calculation Skills
     TM #12 Problem Solving
     TM #13 Basic Algebra Skills
     TM #14 Probability and Statistics
     TM #15 Basic Geometry
     TM #16 Reasoning
     TM #17 Analysis

   - Summarized version of guidelines.
     TM #18

   - Workshop agenda summary to show future processes.
     TM #19

PROCEDURES:

1. Solicit approval and support for program prior to scheduling of inservice. It is critical that the curriculum decision-makers be favorable to the overall concept of math equivalency credit.

2. Select a time that will allow maximum participation and minimum disruption to normal school processes.

3. Establish date, time and place for workshop. Notify participants.

4. Arrange for workshop presenters and/or facilitators.

5. Collect, duplicate and organize workshop materials.

6. Conduct inservice session.

   - History, rationale of math equivalency credit and determination of math content.

     * Oral presentation using transparencies TM 1 thru #17 and HO #1. (30 minutes - 45 minutes)

* Small group discussion on concepts in presentation. Assure that small groups are a balanced mix of math and vocational instructors.
  (30 minutes - 45 minutes)

* Summarize discussions in large group.
  (30 minutes)

- Criteria for meeting math requirements.

  * Oral presentation using transparencies TM #18 and HO #2.
    (10 minutes)

  * Small group discussions on criteria with math and vocational instructors. Determine agreement and disagreement on criteria statements. Revise criteria statements until both groups are in agreement. Write on butcher paper and tape on wall prior to large group session.
    (30 minutes - 45 minutes)

  * Large group discussion on criteria with revision of statements to achieve consensus. Use butcher paper to record consensus or majority/minority reports.
    (30 minutes - 45 minutes)

- Next steps to be taken toward math equivalency credit.

  * Oral presentation using transparency TM #19 and HO #3 on the next steps to be taken in process.
    (20 minutes)

  * Determine who wishes to participate in in next sessions.

- Collect evaluation of inservice sessions from participants.
  HO #4

TOPIC OUTLINES -- AMPLIFICATION AND DISCUSSION

The primary purpose of this document is to clarify the language and terminology of the math checklist. It will be helpful if both the core teacher and the elective teacher discuss the math topics and familiarize themselves with their expectations of the program. The checklist and supporting arguments were developed by a subcommittee of the Oregon Math Educators Council. Ron Zaraza was the committee chairman and gave permission to use the paper and checklist.

BASIC ARITHMETIC SKILLS

Section A of the checklist focuses on the application of basic arithmetic skills. The development of the concept is not a topic on the checklist because most mathematicians have assumed that prior study has developed the concepts. Most of the terminology is self explanatory and little discussion is needed. However, the term "order" refers to the mathematical definition. Greater than or less than order may be substituted in most applications for the word tolerance, gap or spacing. Each elective teacher needs to identify their own use of order since this topic will vary widely depending on the vocation being considered.

MEASUREMENT

Section B of the checklist deals with measurement. This is one of those topics that often we all assume students who reach high school have mastered, at least at a minimum competency level, but practical experience of classroom teachers indicates otherwise. While most students may know the basic English units, their mastery of the metric units is minimal. Even within the units learned, knowledge involves ability to measure whole units, such as inches, only. Fractions of units are a mystery. The actual value of the individual markings on various measuring devices are a mystery to a majority of secondary students. This makes it impossible for the students to really measure.

One of the most basic skills used by everyone is that of measurement. It is impossible to conceive of working in the vocational or technical areas without the use of systems and tools of measurement. Further, in the life experiences of virtually everyone, measurement is an ever-present activity, used for everything from cooking to buying rugs, clothes, or a house. It is the most generally applicable skill in most elective areas.

Because of the applicability of measurement, it is the general topic through which so many of the other math topics may be integrated. Computation, reading and interpretation, use of formula, fractions and decimals, informal geometry, problem solving, and other topics can all be developed through the use of measurement skills. If such a study of measurement is developed in the elective course from an integrated approach as opposed to a discrete study, it is felt there will be a greater understanding of the concept and a greater use of time.

A. Measurement Tools

Most students are familiar with measurement tools for linear measurement such as the foot ruler or yard stick. The elective course should expose students, in a real way, to as many measuring tools as is practical. General rules for using scales should be developed. Students should be measuring the dimensions of actual objects. The results and accuracies determined this way can be compared to more sophisticated devices such as the vernier caliper and micrometer. Particular attention should be paid to the use of vernier devices, which have broad application in many fields. Comparative accuracy in measuring small objects with a simple ruler, a caliper and a micrometer can provide excellent practical experience.

All of these devices, however, are essentially linear scales. It is also desirable that students learn to interpret readings displayed on non-linear scales. "Common, non-professional tools" such as compass, gap meters and transits provide excellent practical experience. Many such tools are commonly used in the trades and elsewhere. Electrical multimeters provide a useful and simple way of teaching non-linear measurement scales. When examining the use of formula, actual applications and use of Ohm's law can both test the student's ability to apply formula and to use non-linear scales. Most multimeters have one or more functions displayed non-linearly.

The checklist also surveys tools that measure volume and area. Tools for measuring volume are common, but tools that measure area may not be so common. This project found two applications of area tools. Tiles and overlays were the only cases, but the use of overlays may be an integral part of developing a mathematical concept of area besides being an important application in some vocational fields.

B. Extended Measurement Tools

Extended measurement tools focus mainly around the use of the computer. Many elective programs do not use the computer, but the use is increasing and recognition of potential use is made here. The math topic checklist terminology in this section is usually clear to the staff who use the computer, but may need explanation to non-computer users.

This topic is of highest priority among the measurement topics in that it demands a change in most elective programs to meet the needs of todays "high tech" society. While important, it is of little use in basic or introductory programs. Computers as tools, rather than for programming, should be the focus of the elective course. For the type of student who would be taking the vocational courses, computers will be a constant factor in life and work. Use of the computer as a word processor, test instrument or simulator will become increasingly common. Students who will have to function in that work/school environment can be prepared for it in this program. They can be trained to be "computer literate" in a truer sense than the narrow sense of the past. This means they should be trained in use and selection of software, including data bases and spread sheets, as well as basic operation. This training cannot be exhaustive, but can be integrated with some of the other topics, including the other measurement topics. Emphasis must be on use of the many capabilities of the computer.

In addition to computers, other advanced tools should also be used to prepare the student who is more generally competent in measuring skills. One obvious device which suggests itself is the oscilloscope. Learning to use it to measure frequency and voltage will give students some exposure to the use of "high-tech" devices while at the same time further developing their understanding of measurement.

C. Approximation

It is important to note that both measurement and calculation approximations are considered. The role of approximation in measurement and calculation is poorly understood by most students. That any measurement is itself an approximation is not at all apparent to the population at large. Students should, through the use of successively more accurate measuring devices, become aware of this. The role in assembly of parts and in the ordering of raw materials can be examined through problems in which tolerances are discussed. A practical activity, such as the number of 6 inch blocks which can be obtained from an eight foot 2 x 4 is an excellent way of illustrating this concept. "Guesstimate" skills such as pacing, hand spans or arm lengths of an object help develop practical approximations and should be encouraged.

Approximation in calculation is also a desirable skill. This is an essential skill for determining "reasonableness of answers." It can be developed by rapid oral drill followed by actual calculation, either hand or calculator, or by estimation followed by experimental verification, as in the case of volume calculations. In either event, this skill should be reviewed frequently, particularly when extensive calculations are to be carried out. This is an excellent motivator for review or mastery of the multiplication facts.

D. Measurement Skills

It is essential to recognize that most students really only have experience with and are reasonably competent with linear measurement. Experience with area, volume, and angular measurement is minimal. An excellent illustration is the question included in the popular board game, Trivial Pursuit, which asks players to differentiate between two square miles and two miles square. Many well educated players have difficulty explaining the difference both in measuring and calculating areas. Further, volume measurement must also be developed. This is particularly easy to do if integrated with the use of a variety of measuring tools and developing a sense of accuracy.

E. Units of Measurement

There are many systems of measurement other than the metric and English systems. Some of them are specific to the vocational program. Some of the units within those systems may be bushels, or horsepower or acres. Elective programs also specify the format and usually it is either the decimal or fraction format. In either case, the student must be provided practical applications in that system as well as familiarity with other formats.

Students will have some proficiency in the English system of units. In developing the use of measurement tools and various types of measurement, other units should be developed. Chief of these, with the gradual metrification of America, should be the metric system. Other quantities, such as torque, which is measured when tightening a bolt on an engine, or board feet, used in the construction and timber industries, should also be developed. Students should be made aware that systems of units are arbitrary, devised for convenience in measurement. By physical comparison they should be encouraged to develop a "feeling" for various systems. Again, this can be developed by comparitive measurement of objects with a variety of devices.

COMMUNICATION

Communication is one of the primary skills both the vocational and mathematical teachers attempt to address. Communication is a skill that needs little justification or explanation for this skill is primary to any study of mathematics or vocation. However, work with teachers in both fields has uncovered a difference in language being used. The language of mathematics is not always the language of the vocation. For example, the mathematical concept of slope is an integral part of most mathematics programs. But words like "grade" and "pitch" are more commonly used for the same concept in certain vocations. MAKING MATHEMATICS AN INTEGRAL PART AND A FUNCTIONAL TOOL OF OUR STUDENTS is the intent of this section and this project.

In looking at Communication, it is important that more than the use of common language be considered. In all the technical and vocational areas a broad variety of communication skills are needed. Communication should not be confined to writing skills. Reading, speaking, and listening skills are just as important. Skills in listening, taking and following directions, taking orders over the telephone, listening to speakers, or listening to taped materials are vital listening skills to develop. Reading assignments should go beyond the textbook. Exercises, reference materials, magazines, maps, charts, tables, and work orders are just a few of the materials which might be used in the Voc/Tech world. Making oral reports, answering customers' questions, working in small-group planning sessions, interviewing for jobs or speaking on the phone are additional communication skills that will be needed.

A. Technical Writing

All of the many aspects of technical writing may include mathematical skills directly or indirectly. Actual mathematical computations or presentations may be part of the writing. Alternatively, the writer may simply present reports.

Proposals are another word for "bids" to contractors, as is "budgets" to the homemaker. Whatever the name is for a proposal, most vocations use proposals. Often times these proposals require more mathematical computations than simple estimates and can become the life blood of a profession's success. Mistakes in calculation, poor interpretation, or unintelligible presentations can result in loss of work and money. Applications may be included in proposals under certain circumstances.

Some applications may require specialized writing, either financial statements or legal documents. The format may be as important as the language. Funding statements may vary from reconciliation of checkbooks to a financial statement for a bank. Preparation of a tax statement is another funding statement.

Research is no more than collecting data. Calculations are often needed, however, for abstract measurements. In presenting the data or calculations, a variety of formats, ranging from charts and graphs to spread sheets, may be considered. Combinations of different formats are necessary for different readers. The collation of data and the order and clarity of the information may be the difference between success or failure. Computers can assist in this, but they cannot evaluate, draw conclusions, or report them.

Summative evalautions are not just answers, but may include forecasts and recommendations. Development of a conclusion and the reporting of the process in a concise statement are expectations of technical writing. These skills can and must be developed, particularly in and around the application of mathematics.

B. Extended Projects

Extended projects are a key part of the integration of mathematics. Through these type projects the full array of skills and applications have a chance to infuse into the students' studies. Extended projects are multi-day activities using problems that require more than one level of technical writing. They may require the student to interpret and develop a process for solving the problem, execute the strategy, and report the results over a multi-day period. Extended projects are examples of what should be the primary function of instruction and provide the vehicle for developing and practicing multiple content.

Projects may involve the whole class in building a house or setting up a mock business. Students going out and collecting the information on the market basket and reporting the results in the school newspaper is another example of an extended project. Other projects may involve work in the community. The extended project can bring mathematics into the community and makes mathematics a tangible tool. Mathematics through extended projects gives the students a feeling of ownership and enhances interest. It also gives students an opportunity to develop reasoning skills.

C. Reading and Interpretation

Reading and interpretation are two skills that seem obvious to most teachers, however, there seems to be a difference of opinion as to common language. The development of the information age has required students to process more and more information and to interpret that information from multiple forms. Most information appears in at least one of five forms. Written form is no more than reading prose. Charts may include blue prints, maps, survey plots, schematics, or diagrams. Graphs are grids that compare one variable of data against some other. Data, in the context of this paper, are tables of information, such as population counts, trigonometric tables, conversion tables or equipment lists with code number

listings. The spread sheet is much like a table except that it also includes summative results such as monthly totals. Students should be given the opportunity to work with each of these representive forms of information.

D. Oral Communication

Oral communication skills are the most neglected in any part of school except possibly speech and drama classes. Todays classroom is not much different than the television in the home. Students sit in front of their teacher listening to the chatter and watching the electrons flow by. Those same students do not practice the skill of oral communication with their parents or their teacher. Most teachers are appalled by the unintelligible or non-factual conversations they have with their students. For the most part, mathematics education has not addressed this problem.

Students need to practice their oral communication. They need to be able to speak correctly and report information accurately. Answering the phone is a good exercise. Taking orders over the phone, in which they get nine or ten pieces of information and are then asked to report them, can be amusing; but it develops a number of communication skills. Written work is not sufficient. Much of what the student does in later life will require good oral communication skills as well as the written skills.

BASIC COMPUTATIONAL SKILLS

This section is different than the basic arithmetic skills section in that it refers to the computational skills being developed as opposed to the concepts being taught. It should also be understood that the computation being taught is from a focus of a tool for problem solving and not an end in itself. It is important that the arithmetic skills be seen as a means to an answer and not the answer. This must be emphasized for both the student and instructor. It is essential that these courses not become endless exercises in pencil and paper computation.

A. Computation

Computation is a significant part of the mathematics curriculum, but it should not be the only focus. The inclusion of calculator skills along with paper and pencil skills is to increase computation skills through different means. But also included is the choosing of the most appropriate methods. Sometimes it is more advisable to mentally computate the fact than to use a calculator. Students need to learn what tool is appropriate for the problem. To do arithmetic today, mental operations are best for obtaining quick approximations, calculators are tools for complex computations, and computers are tools for repetitive calculations. Few real life applications problems are done with paper and pencil computations. Emphasis is also given to the reasonableness of an answer, for in many cases exactness of the answer is not as important as the reasonableness of that answer. However, in some professions precision is required to a significant figure. In all cases, the skills of estimating to a reasonable unit and working with precise answers should be taught.

B. Fractions, Per Cents and Decimals

This section is different than the basic arithmetic skills. In most vocational fields one form is primarily used. It is necessary for the students to understand the preferred form of that vocation so that they can choose the appropriate form. The use of this form in formulae will also be apparent to that vocational field.

C. Money Problems

Money problems have been separated from decimals because there are a number of concepts that require special computational methods. To be able to compute hourly wages, piece wages and commission is an important skill for any worker. It is also necessary for the wage earner to be able to figure taxes and paycheck deductions. The skills of ordering or purchasing are required in most occupations and are most appropriate for students to learn.

D. Extended Calculation Skills

These skills are usually not an integral part of most vocational courses, but are included in the checklist to help recognize those vocations that are using the different mathematical tools. The understanding of scientific notation and logarithms gives the student the ability to solve more advanced and realistic application problems. The trigonometric ratios provide the means to solve a wide variety of problems from phase angles in complex AC circuits to stress problems in mechanical engineering.

BASIC ALGEBRA SKILLS

It is not the intent of this checklist to explore the formal or theoretical aspects of algebra. It is the intent that certain algebra skills will be taught because of their usefulness in solving practical problems. The algebra skills that are included should be approached as informally as possible and the emphasis should be on their use and not on their mathematical significance.

A. Formulae

Formula concept is an important practical application of mathematics and an integral part of the vocational program. The students ability to understand and use formulae is a justifiable use of time. Considerable time should also be spent on the identification of the appropriate formula. Each student should be able to select the formula that is necessary to solve problems such as formulae that involve perimeter, area and volume of geometric figures. There may be a specific formula that is necessary to the particular vocation and problem, but the selection skill must be developed. Besides the computation with formulae, the student should understand the concepts of formula so that they can use any formulae that is given to them.

B. Algebra Skills

Algebra skills such as manipulation of formula may not be a necessary part of most vocational programs. This skill is usually reserved for more extensive study. However, more and more vocations are requiring algebra skills. Advanced study in specific vocations may include techniques for simultaneous solution of equations and the use of matrices. These skills are particularly useful in electronic related applications. These skills constitute additional tools the students have at their command.

C. Exponentiation

Exponentiation is included on the perception that exponent concepts are necessary in the solving of many formulae. However, exponents may not be a primary topic for most vocational courses.

PROBABILITY AND STATISTICS

Generally, most high school students have a minimal competency in probability and statistics. Students do not know how to compute an average or the simple probability of an event. Probability and statistics is not only a basic life skill, but is one which is used frequently in on-the-job settings. A student should know the difference between, and how to compute such values as, mean, median, mode and probabilities of chance events. In many simple cases, sampling is important. For example, in agriculture, samplings are taken to determine grades and, thus, the purchase value of the crop. Most importantly, students will have experiences at interpreting statistics. The student should be made aware of how statistics can be used to mislead, false advertise or sell an inferior product. Some exposure to the topic of statistics and how data is gathered and presented will provide them with information which will prepare them to make more intelligent choices.

Most high school math classes in probability and statistics use more extensive tools to measure data than the basic ones mentioned above. Few vocational courses will ever use or teach these tools. It is not the intent that the vocational courses teach more analysis, but there may be occasions that such a course may need to use one of the analysis tools.

BASIC GEOMETRY SKILLS

This section, like the basic algebra skills section, is not intended to explore the formal or theoretical aspects of geometry. The emphasis should be placed on the practical aspects of the application of geometry skills.

A. Informal Geometry

Informal geometry is often linked to the more conceptual development of geometry. It may also be linked to formula in that the formula is associated with a geometric concept such as perimeter, area and volume. Because of the applied nature of these courses, there is often reason to develop specific terminology when one connects the mathematical shapes and language with that of the vocation. There are also many basic properties

of geometry that are useful in the vocations. The parallel concepts and triangle properties are but two that are used. There also is need to teach specific vocational transformations (moving a shape to another site) and visualizations (seeing three dimensional shapes from two dimensional drawings). Blueprinting is more of a vocational term and here means making a two dimensional drawing from a three dimensional model.

B. Extended Geometry Skills

Extended geometry skills are more advanced skills that not all vocational courses use. Making a three dimensional model from a two dimensional shape is modeling. Making a dress from a pattern or building a boat from a blueprint are examples of modeling. The terms similarity and congruence are geometric terms or concepts that are developed in a geometry course to explain equivalent shapes or proportional shapes. These skills are essential when using scales in constructing a model or blueprinting. The higher caliber vocational student may also develop a need for more advanced measuring skills. The use of transits often require the Pythagorean formula or right triangle concepts of trigonometry. There also may be some vocational fields where coordinate geometry is used. Layout procedures is a good example.

REASONING

The concept of reasoning in this checklist is divided into four essential sequential skills: a) formulating, b) analyzing, c) solving and d) interpreting. The section on problem solving addresses the two skills of analyzing and solving of the problem, while the critical thinking section addresses the formulating and interpreting skills of reasoning.

A. Problem Solving

Problem solving is the analysis of the problem and finding the solution to the problem. So that there is no misunderstanding, problem solving is not just word problems. In analyzing the problem, the student needs to identify features central to the problem and plan a strategy to deal with the different features. Here such strategies as guess-check-refine, creating models, simplifying the problem, making patterns, making tables, working backward, estimating, drawing diagrams, listing similar elements and breaking the problem into manageable parts are successful.

Problem solving is a process, not a skill. However, mathematical skills, thinking skills and often interaction skills are required for the process development. Solving problems requires using one's skills in unexpected, unplanned and often non-routine situations. It is the study of how to plan a strategy or activity that can be applied or learned in the solution of a problem. The transfer of problem solving skills from one situation to another, and the application of such skills in decision making processes, are necessary in order that individuals may deal successfully with the world around them. It is hoped that the course will not only apply the problem solving process, but, also, provide materials that help develop the students' skills in becoming better problem solvers.

The finding solutions phase is often the primary focus of mathematics classes. Too often, the number crunching does not give way to simple logic and overshadows the process of reasoning. This phase or skill, however, should not dominate the first two phases, nor the last phase of reasoning. Finding solutions may require mathematical skills which are often found in the integrated course, but it should not result in becoming the sole focus of teaching problem solving in the course. In a course where the sole purpose is developing mathematical skills for finding a solution, students are not aware that some problems can be solved without a mathematical formula.

B. Critical Thinking

The critical thinking part of reasoning is the formulation of the problem and the interpretation of results. The formulation of the problem is difficult for students who have only used the textbook approach in their studies. This phase of reasoning needs to become part of the student's development just as does finding the solution. Students must learn to ask questions, clarify relationships and determine what information is needed. Once the problem has been solved, then the student needs to interpret the results. Interpreting the solution requires a review of the problem, its constraints and solutions, judging the validity of translations and checking for accuracy. The interpretation must also involve making correct generalizations and applying the results to solving more sophisticated problems. Finding answers is often more easily tested and structured than critical thinking. But time must be provided for students to step back from the problem and evaluate the process, "Could I have solved this problem another way?"

Critical thinking can not be taught as a discrete block of information. As a process, the strategies that must be taught should permeate each and every vocation where mathematics is used. It is in this arena that most vocational courses excel. The student must be provided enough time to evaluate the best strategy after trying different methods. Too often the textbook's method or the teacher's strategies are the only processes presented.

C. Analysis

Analysis is only projected as a topic in the more technical courses. This is due to the greater sophistication of mathematical skills required in those courses. The checklist refers to extended methods beyond the simple techniques of problem solving which are used to help analyze problems. With the development of computers and the study of matrices, large blocks of data can be analyzed. Spread sheets and data management systems are examples of programs for which students must develop rules for different patterns of numbers or shapes. The use of calculators and computers has provided alternative methods for interpolation and extrapolation of data. So, also, the computer can be used to analyze, graph and determine the relationships that exist between the variables.

D. Advertising

Advertising may be representative or misleading depending on how one uses the numbers. There is psychology as to how you represent your product and yourself. Most vocations work on the profit theory, yet there are occasions that work is done for the goodwill of the company, and often those occurrences are done at a loss. The indirect results of the goodwill may lead to more positive results in the future. Students should recognize the purpose of advertising from its mathematical basis, as well as its psychological value.

PROGRAM ORGANIZATION

Standards for determining math equivalency credit must be established and carefully monitored to assure a continuance of quality instruction. The program must be organized in a way that math applications occur by design rather than by happenstance.

Each vocational program must be examined for its math applications. Programs are approved according to the applications of mathematical concepts made within the sequence of classes within a two-year program.

This project has defined some guidelines for implementing and operating math equivalency credit programs (integrated math). The guidelines resulted from problems, constraints and successes of the project. Other schools who wish to implement similar programs should consider the following:

1. The leadership for an integrated math program should arise from mathematics teachers, vocational instructors and school administrators.

2. A math skills checklist should be utilized as a benchmark for relating mathematics and vocational education. The skills checklist breaks mathematics into its many concepts.

3. Standards must be established for controlling the quality of math instruction in vocational classes. Written guidelines for program certification and monitoring must be developed.

A. Criteria for Selecting and Approving a Program for Math Equivalency Credit

A series of courses make up a two-year vocational program. Each courses in the two-year sequence is evaluated according to the application of mathematics concepts. The selection of course sequences is based on the analysis using the math checklist.

Guidelines for establishing math equivalency credit are explained in detail below. All elective programs/courses for which equivalency credit is to be considered, must make application to the review committee or board.

1. Vocational program must be a district approved vocational program (two years). The sequence of courses are clearly defined and have been approved by the review team. Math credit will only be given for completion of a series of courses that have been approved for the math credit.

2. Curriculum includes math daily (a minimum of one-quarter of time in the sequence) in one of the following ways:

   a. reviewing or introducing math skills; and/or
   b. using math applications.

3. Math concepts are clearly defined in writing.

4. Vocational staff involved in the program must have a strong commitment to teaching mathematics as an integral part of their curriculum.

5. Minimum math concepts have been clearly defined utilizing the Math Task Checklist. There are 134 items on the checklist; 40 items must receive a 3 rating; 77 items must be rated 2 or 3. Only 17 items can be missing from an approvable course sequence.

B. Equivalency Credit Process for Approval

1. All elective programs for which equivalency credit is to be considered must make application to the review committtee. (see item #7 below and Application Form, HO #6)

2. At the time of application a representative from the core area will be assigned to work with the elective program applicant through the review process.

3. The equivalency credit applicant must meet with the core department for input on completing the math equivalency credit checklist.

4. If the application involves a program that has received prior approval at another school in the district, approval will be granted provided there is verification the curriculum will be the same.

5. The equivalency application form and the math equivalency checklist can be picked up by the applicant from the building principal, assistant superintendent or the district vocational curriculum coordinator.

6. All building principals impacted by the application will be informed by the coordinator of the initiated application.

7. The review committee or board will consist of the :

   a. district subject area resource teacher;
   b. building administrator (preferably the person responsible for the core curriculum area);
   c. core teacher representative;
   d. elective program teacher;
   e. curriculum coordinators, vocational and/or secondary.

8. Deadlines for submitting requests:

   o End of November - Initial request, review started.
   o Middle of January - Decision, adjustments identified.
   o Middle of February - Final review, approval.

C. Course Sequences for Math Equivalency Credit

Math equivalency credit options must be clearly defined in the school catalog. The following example was taken from the Crescent Valley High School Catalog.

Math Equivalency Credit Program

Math/Drafting	Course 601	Prerequisites - None
Math/Office Occupations	Course 602	Prerequisites - None
Math/Accounting	Course 603	Prerequisites - None
Math/Electricity-Electronics	Course 604	Prerequisites - None
Math/Home Economics	Course 605	Prerequisites - None
Math/Auto Mechanics	Course 606	Prerequisites - None

An integrated math program is designed to allow math credit for students enrolled in certain vocational programs. To qualify for one math credit, a student must complete an approved vocational program in one of the above areas. The student will be awarded the math credit upon completion of the approved sequence of courses. (Listed below). To sign up for this program, a student must sign up for the special course designation which has math included in the name along with the vocational program.

ONLY ONE MATH CREDIT OF THE FOUR REQUIRED FOR GRADUATION MAY BE EARNED THIS WAY.

Drafting - Two years. Any combination of Drafting I, II, III, IV or Architecture.

Office Occupations - Office Procedures (one year), Business Machines (one semester), Accounting I (one semester).

Accounting - Accounting I (one year), and one year of Accounting II or Accounting III.

Electricity-Electronics - Any combination of four semesters of : Basic Electricity I, II; Electricity/Electronics III, IV; Advanced Electronics V, VI; Senior Electronics VII, VIII.

Home Economics - One semester each of Basic Foods, Advanced Foods and Living on Your Own and one semester of either Basic Sewing or Individualized Sewing.

Auto Mechanics - Career Mechanics (one year) and two semester of any combination of: Auto I (one year), Auto II (one year), and Career Mechanics (second year).

D. Process for Student Registration

Counselors are a critical part of managing, advising and recording student activities. First, a computer number should be assigned for the math equivalency credit of each program. This number is listed on all registration materials and in student catalogs.

Orientation programs involve counselors, math and vocational education staff. Counselors advise students through 8th and 9th grade orientation sessions. Informational posters are placed in classrooms and in strategic locations around the building. Parents are advised of the program at 8th grade parent night, through parent newsletters and ninth grade orientations sessions. Other staff members are advised in general faculty meetings, department meetings and through curriculum fliers. Counselors need to be regularly up-dated as to the status of approved course sequence and any changes in the program.

Counselors are critical to the registration process. They make sure that the course catalog contains all information that is pertinent to the math section and vocational programs. The catalog should include a program description and an equivalency credit number. Counselors should follow-up the student registration with a memo having staff verify that all students who wish to participate in the program are registered (see HO #7).

E. Maintaining Quality

1. Teachers of math equivalency courses must include the continued maintenance of course quality as a goal to be evaluated by the building principal. (every 2 years)

2. Assessment during the odd year will consist of occasional contact between the equivalency credit teacher and review committee members to assess whether program standards are being maintained.

3. When either core or equivalency staff turnover occurs, the new teacher should be given an orientation to the math equivalency credit process and secure commitment to the implementation of this approach.

F. Course Sequence Requirements

Vocational courses vary in their applications of math concepts. Each series of classes that make up a program must be carefully evaluated. The math credit will only be given for completion of a series of classes that have been certified for integrated math credit. The following course lists (by school and program area) show the sequences needed for integrated math credit.

Crescent Valley High School

Drafting	Mechanics
Any two year combination of Drafting I, II, III, Drafting IV (CAD) or Architecture.	Career Mechanics (One Year) and two semesters of any combinations of: Auto I (One Year) Auto II (One Year), and Career Mechanics (Second Year)

Accounting

Accounting I (one year)
and one year of Accounting II
or Accounting III

Consumer Homemaking

One semester each of Basic Foods, Advanced Foods and Living on Your Own and one semester of either Basic Sewing or Individualized Sewing

Office Procedures

Office Procedures (one year)
Business Machines (one semester)
Accounting I (one semester)

Electricity/Electronics

Any combination of four semesters of: Basic Electricity I, II; Electricity/Electronics III, IV; Advanced Electronics V, VI; Senior Electronics VII, VIII

Corvallis High School

Drafting

Any two year combination of Drafting I, II, III, Drafting VI (CAD) or Architecture.

Mechanics

Advanced Mechanics (One Year) and two semesters of any combinations of : Auto I (Semester), Auto II (Semester), Car Care (Semester), and Introduction to Mechanics

Accounting

Accounting I, II
(One year each)

Consumer Homemaking

One semester each of Exploring Childhood, Living on Your Own and Sewing Lab and one semester of either Basic Foods or Advanced Foods

Office Occupations

Office Procedures (one year)
Business Machines (one semester)
Recordkeeping/Accounting (one semester)

Electricity/Electronics

Any combination of four semesters of: Basic Electricity I, II; Electricity/Electronics III, IV; Advanced Electronics V, VI; Senior Electronics VII, VIII

Woods

Rec. Woods (semester)
Advanced Woods (1 year)
Spartan Craftsman (semester)

WORKSHOP AGENDA

NEXT STEP

DATE:

TIME:

PLACE:

1/2 HOUR - 1 HOUR	SMALL GROUP -- MATH/VOCATIONAL TEAMS ACTIVITY: Review vocational curriculum guides for math components
20 MINUTE- 35 MINUTES	LARGE GRUOP -- SEVERAL TEAMS ACTIVITY: Discuss current emphasis on math in curriculum guide
10 MINUTES- 25 MINUTES	FACILITATOR ACTIVITY: Explain checklist
3 1/2 HOURS- 4 1/2 HOURS	MATH/VOCATIONAL TEAMS ACTIVITY: Complete checklist
1/2 HOUR	MATH/VOCATIONAL TEAMS ACTIVITY: Identify course sequences
10 MINUTES	MATH/VOCATIONAL TEAMS ACTIVITY: Approve/disapprove course sequences
1/2 HOUR	MATH/VOCATIONAL TEAMS ACTIVITY: Complete math equivalency approval application
10 MINUTES	WORKSHOP PARTICIPANTS ACTIVITY: Evaluate workshop
10 MINUTES	FACILITATOR ACTIVITY: Explain next step
6 HOURS	TOTAL WORKSHOP TIME

PARTICIPANT EVALUATION

Please circle the most appropriate rating for this inservice session.

	Excellent	Good	Average	Fair	Poor
1. The objectives of this session were clearly identified prior to the beginning of the activities.	5	4	3	2	1
2. Communications with participants in regard to this session were timely and clear.	5	4	3	2	1
3. Activities were meaningful and productive in relation to the workshop objectives.	5	4	3	2	1
4. Timelines were appropriate to the activities being conducted.	5	4	3	2	1
5. Inservice facilitators were helpful in meeting the objectives of the session.	5	4	3	2	1
6. Outcomes of this session met my expectations.	5	4	3	2	1

COMMENTS:

SECTION A OF MATH CHECKLIST

BASIC ARITHMETIC SKILLS

1. WHOLE NUMBERS
2. FRACTIONS
3. DECIMALS
4. PER CENTS
5. CONVERTING
6. ORDER AND EQUALITY RELATIONS
* 7. INTEGERS
* 8. IRRATIONAL AND COMPLEX

* Only covered in specialized vocational programs.

SECTION B OF MATH CHECKLIST

MEASUREMENT

1. MEASUREMENT TOOLS

- LINEAR
  - Calipers
  - Rulers
  - Micrometers
  - Gauges
- NON-LINEAR
  - Multimeter
  - Gauges

SECTION B OF MATH CHECKLIST

MEASUREMENT

* 2. ADVANCED MEASUREMENT TOOLS

- COMPUTERS
  - Software
  - Data Bases
  - Spread Sheets
- OSCILLOSCOPE

* Only covered in special vocational programs.

SECTION B OF MATH CHECKLIST

MEASUREMENT

3. APPROXIMATION

- GUESTIMATES
- REASONABLENESS OF ANSWERS

4. MEASURMENT SKILLS

SECTION B OF MATH CHECKLIST

MEASUREMENT

5. TYPES AND UNITS OF MEASUREMENT

- TYPES
  - Linear
  - Volume
  - Angular
  - Area
- UNITS
  - Metric
  - English

SECTION C OF MATH CHECKLIST

COMMUNICATIONS

1. TECHNICAL WRITING

- PROPOSALS
  - Bids
  - Budgets
  - Financial Statements
  - Tax Statements
- RESEARCH
  - Charts
  - Graphs
  - Conclusions

SECTION C OF MATH CHECKLIST

COMMUNICATIONS

2. EXTENDED PROJECTS

- MULTI-DAY ACTIVITIES
- PROBLEM-SOLVING
- STRATEGY EXECUTION
- REPORTING
- COMMUNITY/SCHOOL BASED PROJECTS

SECTION C OF MATH CHECKLIST

COMMUNICATIONS

3. READING AND INTERPRETATION

- WRITTEN FORM
- CHARTS
  - Blueprints
  - Maps
  - Schematics
  - Diagrams
- GRAPHS
- DATA
  - Population Counts
  - Trigonometric Tables
  - Conversion Tables
- SPREAD SHEETS

4. ORAL COMMUNICATION

SECTION D OF MATH CHECKLIST

BASIC COMPUTATIONAL SKILLS

1. COMPUTATION
   - ESTIMATION
   - CALCULATOR
   - MENTAL COMPUTATION
   - PENCIL AND PAPER

SECTION D OF MATH CHECKLIST

BASIC COMPUTATIONAL SKILLS

2. FRACTIONS, PER CENT, DECIMALS

- UNDERSTAND CONCEPTS
- SELECT APPROPRIATE FORM
- USE IN WIDE RANGE OF APPLICATIONS

SECTION D OF MATH CHECKLIST

BASIC COMPUTATIONAL SKILLS

3. MONEY PROBLEMS
   - WAGES
   - TAXES
   - PAYROLL DEDUCTIONS
   - ORDERING
   - PURCHASING
   - COMMISSIONS
   - DISCOUNTS

* 4. EXTENDED CALCULATION SKILLS

* Only covered in specialized vocational programs.

SECTION D OF MATH CHECKLIST

BASIC COMPUTATIONAL SKILLS

5. PROBLEM SOLVING

- MATHEMATICAL SKILLS
- THINKING SKILLS
- INTERACTION SKILLS

SECTION E OF MATH CHECKLIST

BASIC ALGEBRA SKILLS

1. FORMULA
   - IDENTIFICATION
   - USE
   - REFERENCES

* 2. ALBEGRA SKILLS

* 3. EXPONENTIATION

* Only covered in specialized vocational programs.

SECTION F OF MATH CHECKLIST

PROBABILITY AND STATISTICS

1. BASIC
   - AVERAGES
   - SAMPLING
   - OPPORTUNITIES

* 2. ANALYSIS

* Covered only in specialized vocational programs.

SECTION G OF MATH CHECKLIST

BASIC GEOMETRY

1. INFORMAL

* 2. EXTENDED

* Covered only in a specialized vocational program.

SECTION H OF MATH CHECKLIST

REASONING

1. PROBLEM SOLVING
   - TECHNIQUES
   - MATERIALS

* 2. CRITICAL THINKING
   - PROBLEM FORMULATION
   - INTERPRETATION OF RESULTS

* Covered only in a specialized vocational program.

SECTION H OF MATH CHECKLIST

REASONING

* 3. ANALYSIS

- INTERPOLATION
- EXTRAPOLATION

* 3. ADVERTISING

- DIRECT AND INDIRECT METHOD
- GOODWILL

* Covered only in specialized vocational programs.

CRITERIA FOR MATH EQUIVALENCY CREDIT REQUIREMENTS

- APPROVED VOCATIONAL PROGRAMS (2 YEARS)
- APPROVED COURSE SEQUENCES
- MATH INCLUDED DAILY AS:
  - Introduction of Math Skill
  - Review of Math Skill
  - Applications
- MATH CONCEPTS ARE DEFINED IN WRITING (CHECKLIST)
- STAFF COMMITMENT

NEXT STEPS

WORKSHOP (SIX HOURS - EIGHT HOURS)

- COURSE SEQUENCE IDENTIFICAITON
- CURRICULUM GUIDE REVIEW
- MATH CHECKLIST/VALIDATION OF MATH APPLICATIONS
- APPROVAL OF COURSE SEQUENCES FOR MATH CREDIT

III. WORKSHOP

- CURRICULUM REVIEW
- CHECKLIST COMPLETION
- COURSE SEQUENCE IDENTIFICATION
- APPROVAL OF COURSE SEQUENCES

III. WORKSHOP

RECOMMENDED TIME:

6 - 8 hour session during school day, inservice day or Saturday work day.

TARGET AUDIENCE:

Math instructors and vocational instructors working in small team relationship.

INSERVICE OBJECTIVES:

1. Review existing curriculum guide to examine degree to which math is now included in written curriculum.
2. Complete math checklist to identify specific math applications in each course.
3. Identify course sequences that offer justification for math equivalency credit.
4. Obtain approval of course sequences for math equivalency credit by math instructors.

DESIRED OUTCOMES:

1. Identification of math concepts being taught in specific vocational classes.
2. Identification of 2 year course sequences that merit math equivalency credit.
3. Approval of course sequences for math equivalency credit.

MATERIALS NEEDED:

1. Curriculum guides for each vocational program represented at workshop; textbooks, instructor's manuals and supplementary materials. (Instructors will provide)
2. Math equivalency checklist for each workshop participant.
   HO #5
3. Handouts from the orientation session for reference.
   HO #1, #2, #3
4. Evaluation instrument for inservice session.
   HO #4

5. Blank math equivalency credit application.
   HO # 6
6. Assignment for math/vocational teams to prepare for staff development workshop session.
   HO #7

7. Transparency Masters

   TM #20 Page from Completed Checklist
   TM #21 Completed Equivalency Credit Application
   TM #22 Agenda for Professional Development Workshop (Next Step)

PROCEDURES:

1. Solicit approval and support for workshop from school administrators.

2. Select an appropriate time for workshop.

3. Establish date, time and place for workshop. Vocational area is suggested. Notify participants.

4. Arrange for facilitator for workshop.

5. Collect, duplicate and organize workshop materials.

6. Conduct workshop sessions.

   - Have small groups (math/vocational) review curriculum guide for vocational program.
     (30 minutes)

   - Discuss the degree of math emphasis in current curriculum guide. Large group discussion.
     (20 minutes)

   - Show participants how to use the math equivalency checklist TM #20 and HO #6.
     (10 minutes)

   - Assign math/vocational teams to completing the checklist. Discussion of frequency and depth of math instruction should be on-going as the teams move through the checklist. Analyze each

approved vocational course in program.
(3 1/2 hours)

- Upon completion of checklist for individual courses, identify course sequences that merit math equivalency credit. Remember that a two year sequence is required for credit.
(1/2 hour)

- Obtain math instructors' recommendations on approval/disapproval of course sequences for math equivalency credit. If conditional approval is given, identify conditions for implementation. (Identify weaknesses, determine how to strengthen weak areas and implement changes.)
(10 minutes)

- Complete math equivalency credit application.

  * Facilitator will show what a completed application should look like. Use TM #21.
  (10 minutes)

  * Have vocational instructor and math instructor review it. Use HO #6.
  (20 minutes)

- Explain professional development inservice. (Next step). HO #7 and TM #22.
(10 minutes)

- Have participants evaluate the workshop session. Use HO #4.
(10 minutes)

- Collect and summarize evaluations to determine the effectiveness of the workshop.
(After workshop)

PARTICIPANT EVALUATION

Please circle the most appropriate rating for this inservice session.

	Excellent	Good	Average	Fair	Poor
1. The objectives of this session were clearly identified prior to the beginning of the activities.	5	4	3	2	1
2. Communications with participants in regard to this session were timely and clear.	5	4	3	2	1
3. Activities were meaningful and productive in relation to the workshop objectives.	5	4	3	2	1
4. Timelines were appropriate to the activities being conducted.	5	4	3	2	1
5. Inservice facilitators were helpful in meeting the objectives of the session.	5	4	3	2	1
6. Outcomes of this session met my expectations.	5	4	3	2	1

COMMENTS:

MATH EQUIVALENCY CHECKLIST

* This checklist is provided for instructors to analyze their own curriculum in relation to the math applications being made in vocational courses.

* The instructor should write in the names of specific courses in the vertical blocks at the top of checklist. The names of programs can be shown in the horizontal block at the top of the checklist. Rate each item according to the scale shown under Math Topics.

* See example below:

MATH TOPICS 0 = Not applicable 1 = Applicable, but not being taught 2 = Taught, but minimum depth and regularity 3 = Taught, maximum depth	ACCOUNTING			OFFICE OCCUPATIONS				DRAFTING				
	ACCOUNTING I	ACCOUNTING II	ACCOUNTING III	BUSINESS MACHINES	ACCOUNTING (1 semester) or	RECORDKEEPING	OFFICE PROCEDURES	DRAFTING I	DRAFTING II	DRAFTING III	DRAFTING IV (CAD)	ARCHITECTURAL DRAFTING
* A. BASIC ARITHMETIC SKILLS												
*1. WHOLE NUMBERS												
* Add	3	3	3	3	3	3	3	3	3	3	3	3
* Subtract	3	3	3	3	3	3	3	3	3	3	3	3

MATH EQUIVALENCY CHECKLIST

MATH TOPICS												
* A. BASIC ARITHMETIC SKILLS												
*1. WHOLE NUMBERS												
* Add												
* Subtract												
* Multiply												
* Divide												
*2. FRACTIONS												
* Add												

MATH EQUIVALENCY CHECKLIST

MATH TOPICS											
* Subtract											
* Multiply											
* Divide											
* Reduce											
* Change improper -- mixed (i.e. $\frac{22}{16}'' = 1\frac{3}{8}''$)											
* Identify equivalent (i.e. $\frac{6}{8}'' = \frac{3}{4}''$)											
*3. Decimals											
* Add											

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HO 5

MATH EQUIVALENCY CHECKLIST

MATH TOPICS											
* Subtract											
* Multiply											
* Divide											
* Significant units (i.e. to the nearest 0.1")											
* Repeating (i.e. $\frac{1}{3}$ = 0.333.....)											
*4. PERCENT											
* Find the percent of a whole											
* Find what percent is a number of the whole											

MATH EQUIVALENCY CHECKLIST

MATH TOPICS											
*5. FRACTION/DECIMAL/PERCENT											
* Change fraction to decimal (i.e. $\frac{1}{4}$ = .25)											
* Change fraction to percent (i.e. $\frac{1}{4}$ = 25%)											
* Change decimal to fraction (i.e. .125 = $\frac{1}{8}$)											
* Change decimal to percent (i.e. .34 = 34%)											
* Change percent to fraction (i.e. 60% = $\frac{3}{5}$)											
* Change percent to decimal (i.e. 86% = .86)											
*6. ORDER AND EQUALITY RELATIONS											

MATH EQUIVALENCY CHECKLIST

MATH TOPICS										
* Equivalent (i.e. A = l x w)										
* Greater than (tolerance)										
* Less than (tolerance)										
* Intervals (gaps and spacing)										
7. INTEGERS										
- Positive and negative numbers										
- Computation with positive &negative numbers										
8. IRRATIONAL & COMPLEX NUMBERS										

MATH EQUIVALENCY CHECKLIST

MATH TOPICS										
* Square roots										
- Pi										
- Natural E (e = 2.781..., natural logs)										
- Complex number ($3 + \sqrt{-.7}$)										
B. MEASUREMENT										
*1. MEASUREMENT TOOLS										
* Common, non-professional tools (compass, gap meters, transit)										
* Linear scales (tape, yardstick)										

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HO 5

MATH EQUIVALENCY CHECKLIST

MATH TOPICS											
* Verniers (micrometers, calipers)											
* Gauges (weight scales, pressure scales)											
* Non-linear tools (protractor)											
* Volume (gallon bucket, graduated cylinder)											
* Area (tiles, overlays)											
2. EXTENDED MEASUREMENT TOOLS											
- Basic computer operation											
- Computer simulation											

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HO 5

MATH EQUIVALENCY CHECKLIST

MATH TOPICS											
- Use and selection of software											
- Spread sheets											
- Data management											
*3. APPROXIMATION											
* Measurement (pacing, hand measurement)											
* Calculation (12" x 28" = 10 x 30 = 300 sq.in.)											
*4. MEASUREMENT SKILLS											
* Linear measurement											

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MATH EQUIVALENCY CHECKLIST

MATH TOPICS											
* Area measurement											
* Volume measurement											
* Angular measurement											
5. UNITS OF MEASUREMENT											
* Specialized in vocational area (horsepower, bushels, acres)											
* Metric											
* English											
* Format--Decimals (1.34 inches, 0.112 acres)											

MATH EQUIVALENCY CHECKLIST

MATH TOPICS											
- Conversion within same system (4 cups = quart)											
C. COMMUNICATIONS											
1. TECHNICAL WRITING											
- Proposals (bids, budgets)											
- Funding (balance sheets, reconcile bank statement)											
- Research (charts, graphs)											
- Data presentation/collection format (field data)											
- Collation											

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HO 5

MATH EQUIVALENCY CHECKLIST

MATH TOPICS											
- Cumulative review (annual report)											
2. EXTENDED PROJECT - long term problem solving project and formal report											
*3. READING AND INTERPRETATION											
* Charts (diagrams, flow charts, schematics)											
* Graphs (bar graphs, pie graphs)											
* Data (tables)											
* Spread Sheets (simple or limited) (data table/summary)											
*4. ORAL COMMUNICATION											

MATH EQUIVALENCY CHECKLIST

MATH TOPICS											
* Use of correct terminology											
* Ability to follow instructions (orally and written)											
D. BASIC COMPUTATIONAL SKILLS											
*1. COMPUTATION (Four basic functions)											
* Pencil & paper											
* Calculator											
* Mental											
* Estimation											

MATH EQUIVALENCY CHECKLIST

MATH TOPICS											
* Development of a "feel" for reasonableness											
* Computer											
* Significant figures											
* Choosing an appropriate method (appropriate operation, appropriate tool)											
*2. FRACTIONS, PERCENTS AND DECIMALS											
* Use of fractions, percent and decimals											
* Identification of when each is appropriate											
* Use in formulae											

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HO 5

MATH EQUIVALENCY CHECKLIST

MATH TOPICS											
* Skill reinforcement											
*3. MONEY PROBLEMS											
* Hourly wage											
* Piece wages											
* Commission											
* Taxes											
* Paycheck deductions											
* Purchasing and ordering											

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HO 5

MATH EQUIVALENCY CHECKLIST

MATH TOPICS											
*4. EXTENDED CALCULATION SKILLS											
* Use of scientific notation											
* Logarithms											
* Use of trigonometric ratios to solve geometric problems											
* Complex numbers											
E. BASIC ALGEBRA SKILLS											
*1. FORMULAE											
* Identification of appropriate formulae											

MATH EQUIVALENCY CHECKLIST

MATH TOPICS													
* Use of formulae by insertion of values													
* Development of knowledge which will aid in locating formulae													
2. ALGEBRA SKILLS													
- General review													
- Manipulation ($\frac{d}{t} = r \Rightarrow d = tr$)													
- Simultaneous solutions $\begin{array}{r} 2x + 3y = 9 \\ 3x - 3y = 11 \\ \hline 5x \quad\quad = 20 \end{array}$													
- Use of matrices													
*3. EXPONENTIATION													

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MATH EQUIVALENCY CHECKLIST

MATH TOPICS											
* Basic concepts $(X^2)^3 = X^6$											
* Use in formulae											
F. PROBABILITY AND STATISTICS											
*1. BASIC PROBABILITY AND STATISTICS											
* Averages											
* Chance of event (probability of event happening--3 out of 4 times)											
* Sampling											
* Data reliability											

MATH EQUIVALENCY CHECKLIST

MATH TOPICS											
* Mean, median, mode											
2. ANALYSIS											
- Diagramming & counting procedures for sample spaces											
- Permutations and combinations											
- Interpolations and extrapulations											
- Inferences											
- Measures of central tendency and dispersion											
G. BASIC GEOMETRY SKILLS											

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HO 5

MATH EQUIVALENCY CHECKLIST

MATH TOPICS											
*1. INFORMAL GEOMETRY											
* Area of regular shapes											
* Identification of regular shapes											
* Vocational/mathematical terminology (barrel as opposed to cylinder)											
* Basic properties											
* Transformations - effect on apparent shape											
* Visualization - construction of models											
* Blueprinting											

MATH EQUIVALENCY CHECKLIST

MATH TOPICS											
2. EXTENDED GEOMETRY SKILLS											
- Modeling											
- Similarity and congruence											
- Indirect measurement and Pythagorean formula											
- Coordinate geometry											
H. REASONING											
*1. PROBLEM SOLVING											
* Techniques											

MATH EQUIVALENCY CHECKLIST

MATH TOPICS											
* Materials											
*2. CRITICAL THINKING											
* Techniques											
* Materials											
3. ANALYSIS											
- Data -- Patterns and rules											
-- Interpolation											
-- Extrapolation											

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HO 5

MATH EQUIVALENCY CHECKLIST

MATH TOPICS												
- Curves — Analyze graph to determine relation between variables												
-- Interpolation												
-- Extrapolation												
4. ADVERTISING												
- Direct and indirect method												
- Goodwill												

CORVALLIS SCHOOL DISTRICT 509J

Equivalency Credit Application

Name_____ Date_____

School_____

1. Proposed equivalent course sequence:

   _____

2. Department for which the equivalent credit will apply (i.e., math, English, science):

   _____

3. Provide the specific high school graduation requirements this course will fulfill.

   _____

   _____

   _____

4. Complete course equivalency checklist, i.e. math, science, English. Attach course curriculum, outlines of courses in sequence).

   _____

   _____

   _____

5. List department(s) and individual(s) with which this application was discussed.

   _____

   _____

   _____

Completed application form must be turned in to the building principal by November 30.

TEAM ASSIGNMENTS FOR STAFF DEVELOPMENT INSERVICE

WHAT:

Each team (math instructor/ vocational instructor) will present 6 math concepts and show theoretical and application treatments of those concepts. Teams will work together in selection of concepts to be presented.

HOW:

Each team should have some time allocated for planning the problem sets to be presented at the inservice.

At the inservice, each team will be allowed 20-30 minutes to show approaches to specific problems. The large group discussions will be directed toward the presentations. Similarities and differencies in approaches; advantages and disadvantages; and complementary features of the two approaches will be discussed.

MATH EQUIVALENCY CHECKLIST

MATH TOPICS 0 = Not applicable 1 = Applicable, but not being taught 2 = Taught, but minimum depth and regularity 3 = Taught, maximum depth	ACCOUNTING			OFFICE OCCUPATIONS				DRAFTING				
	ACCOUNTING I	ACCOUNTING II	ACCOUNTING III	BUSINESS MACHINES	ACCOUNTING (1 semester) or	RECORDKEEPING	OFFICE PROCEDURES	DRAFTING I	DRAFTING II	DRAFTING III	DRAFTING IV (CAD)	ARCHITECTURAL DRAFTING
* A. BASIC ARITHMETIC SKILLS												
*1. WHOLE NUMBERS												
* Add	3	3	3	3	3	3	3	3	3	3	3	3
* Subtract	3	3	3	3	3	3	3	3	3	3	3	3
* Multiply	3	3	3	3	3	3	3	3	3	3	3	3
* Divide	3	3	3	3	3	3	3	3	3	3	3	3
*2. FRACTIONS												
* Add	3	3	3	3	3	3	3	3	3	3	3	3

CORVALLIS SCHOOL DISTRICT 509J

Equivalency Credit Application

Name Chuck Honey Date Oct. 11, 1985

School Crescent Valley High School

1. Proposed equivalent course sequence:

   Any two years of Drafting I, II, III, Drafting IV (CAD), or Architecture

2. Department for which the equivalent credit will apply (i.e., math, English, science):

   Mathematics

3. Provide the specific high school graduation requirements this course will fulfill.

   one math credit of four credits required in mathematics

4. Complete course equivalency checklist, i.e. math, science, English. Attach program curriculum, planned course statements and course outlines of courses in approved sequence).

   Attached are: (1) completed equivalency checklist; (2) planned course statements; (3) course outlines

5. List department(s) and individual(s) with which this application was discussed.

   Math Instructor, Jerry Borden, CVHS; Ada Fancher, Dick Moon.

Completed application form must be turned in to the building principal by November 30.

NEXT STEP

WHAT:	PROFESSIONAL DEVELOPMENT INSERVICE
WHY:	Increase math and vocational instructor understanding of each other's delivery system for mathematics.
WHEN:	1/2 day, _____
WHERE:	In vocational/math classrooms.
WHO:	Math instructors, vocational instructors.
HOW:	Each participant will demonstrate the instruction of 6 math concepts as math/vocational teams.

IV. PROFESSIONAL DEVELOPMENT WORKSHOP

- TEAM PRESENTATIONS
- GROUPS DISCUSSIONS ON PRESENTATIONS
- QUALITY MAINTENANCE

IV. PROFESSIONAL DEVELOPMENT WORKSHOP

RECOMMENDED TIME: 4 hour sharing session on a release day.

TARGET AUDIENCE: Teams of math and vocational instructors.

WORKSHOP OBJECTIVES:

1. Have math concepts presented by math instructors and vocational instructors in a team arrangement.
2. Assess the two approaches to math instruction.
3. Develop on-going team relationships between math and vocational instructors.

DESIRED OUTCOMES:

1. Mutual respect of both teaching approaches by math and vocational instructors.
2. Improved spirit of cooperation between math and vocational instructors.
3. Better understanding of theoretical concepts and their applications in mathematics.

MATERIALS NEEDED:

1. Blackboards, chalk, overhead projector, transparency sheets and marking pens.
2. Handouts:
   - Points to consider in critiquing math approaches. HO 8
   - Evaluation instruments for inservice session. HO 4
3. Transparency Masters:
   - Critique of presentations TM 23
   - Quality maintenance TM 24

PROCEDURES:

1. Make arrangements for release time well in advance of workshop.

2. Select the most appropriate time for workshop. Consider the interval between this workshop and the last one; ability to free teachers from classrooms; and other factors that help to maximize attendance at the workshop.

3. Establish date, time and place for workshop. A vocational classroom is appropriate for this session.

4. Arrange for workshop facilitator well in advance of workshop.

5. Collect, organize and prepare materials.

6. Remind instructors of their assignments at workshop so that all will be prepared.

7. Conduct workshop.

   - Introduce workshop by handing out HO 8 to participants. Explain what they should be observing in the presentation. Use TM 23 to show points to consider in critiquing presentations. (10 minutes)

   - Have each team demonstrate 6 concepts of mathematics with each team member using their own approach. (30 minutes per team)

   - At the end of each team's presentation, conduct a large group discussion on the points outlined in HO 8. (10 minutes per team)

8. After all teams have made their presentations and all discussions are completed, present ideas on how to maintain quality standards in math credit equivalency.
   Use TM 24.
   (10 minutes)

9. Evaluate this workshop session using instrument HO 4.
   (10 minutes)

NOTE: In a 4 hour (240 minute) workshop, 210 minutes should be devoted to the actual presentations and discussion of those presentations. This would allow the involvement of 5 teams for 30 minutes each with 10 minutes for discussion of each presentation.

PARTICIPANT EVALUATION

Please circle the most appropriate rating for this inservice session.

	Excellent	Good	Average	Fair	Poor
1. The objectives of this session were clearly identified prior to the beginning of the activities.	5	4	3	2	1
2. Communications with participants in regard to this session were timely and clear.	5	4	3	2	1
3. Activities were meaningful and productive in relation to the workshop objectives.	5	4	3	2	1
4. Timelines were appropriate to the activities being conducted.	5	4	3	2	1
5. Inservice facilitators were helpful in meeting the objectives of the session.	5	4	3	2	1
6. Outcomes of this session met my expectations.	5	4	3	2	1

COMMENTS:

GUIDELINES FOR CRITIQUING MAIN APPROACHES

1. Can you follow the concept as presented? Can students follow the concept as presented?

2. How are the two approaches similar?

3. How do the two approaches differ?

4. Do the two approaches complement each other?

5. What are the advantages to each approach?

6. What are the disadvantages to each approach?

COMMENTS:

POINTS TO CONSIDER

- EASY TO FOLLOW
- SIMILIARITIES
- DIFFERENCES
- COMPLIMENTARY
- ADVANTAGES
- DISADVANTAGES

QUALITY MAINTENANCE

- EVALUATION BY BUILDING PRINCIPAL EVERY TWO YEARS
- ORIENTATION OF NEW STAFF TO MATH EQUIVALENCY CREDIT
- PERIODIC SELF-ASSESSMENT AND REVIEW

V. GENERAL CHECKLIST FOR PLANNING, ORGANIZING, CONDUCTING AND EVALUATING INSERVICE SESSIONS

- PLANNING
- ORGANIZING
- CONDUCTING
- EVALUATING
- REVISING

GENERAL CHECKLIST FOR PLANNING, ORGANIZING, CONDUCTING AND EVALUATING WORKSHOPS

PLANNING	CHECK
1. Develop a list of workshop participants.	_____
2. Determine the most appropriate time and date.	_____
3. Determine needs for facilities and equipment.	_____
4. Select an appropriate workshop location.	_____
ORGANIZING	
5. Notify participants of workshop details.	_____
6. Make arrangements for facilities and equipment.	_____
7. Duplicate handouts and make transparencies needed in conducting workshop.	_____
8. Arrange for workshop facilitator.	_____
CONDUCTING	
9. Make an appropriate introduction for the workshop.	_____
10. Make an effective presentation of the workshop content.	_____
11. Make an effective summary of the workshop.	_____
EVALUATING	
12. Conduct an evaluation of each session.	_____
13. Summarize evaluations and make revisions for future workshops.	_____

SECTION	CHANGES NEEDED	PAGE
IV. PROFESSIONAL DEVELOPMENT INSERVICE (PROCESS OUTLINE)		
PROFESSIONAL DEVELOPMENT INSERVICE (HANDOUTS)		
PROFESSIONAL DEVELOPMENT INSERVICE (TRANSPARENCY MASTERS)		
V. GENERAL CHECKLIST FOR PLANNING, ORGANIZING, CONDUCTING AND EVALUATING INSERVICES		

GENERAL COMMENTS

FORMAT OF GUIDE		
COLOR CODING		
CONTENT		